# SYNOPSIS

# GEO-ENVIRONMENTAL IMPACT OF COAL ASH FILLING ON GROUNDWATER REGIME SURROUNDIG THE ABANDONED SOUTH BALANDA AND JAGANNATH MINE PITS IN TALCHER, ODISHA

A synopsis submitted to

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Submitted by


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# *SYNOPSIS*

## 1. Introduction

Coal-based thermal power plants have been a major source of power generation in India. 75% of the total power obtained is from coal based thermal power plants. The coal reserve of India is about 200 billion tons (bt) and its annual production reaches 250 million tons (mt) approximately. About 70% of this is used in the power sector (Sahu et. al 2009). Coal quality depends upon its rank and grade. The carbon content in coal is highest in case of Anthracite and is followed by Bitumious coal, Sub-Bitumious coal and Lignite. Indian coal is largely of Sub-bituminous rank, followed by Bituminous and Lignite. In India, unlike the most developing countries, 35-50 % coal ash is generated during power generation (Bhattacharjee and Kandpal, 2002; http://www.hvfacprojectindia.com/Summary Report.pdf; Pandey et. al. 2011). The high fly ash generation is due to the wear and tear in plant and machinery, low thermal efficiency of boiler, slogging choking and scaling of the furnace. India ranks fourth in the world after USSR, USA and China in the production of coal ash (OECD/IEA 1999, Pandey et. al. 2011). According to Fly Ash Utilization Programme (FAUP) and Technology Information forecasting and Assessment council (TIFAC) the total ash production will increase upto 300-400MT in 2017, 500MT in 2022 and likely to touch 1000 MT/yr by 2032. In recent years, fly ash utilization in India has increased substantially from 9.63% in 1996-97 to 54.33% in 2011-12(Emamul Haque 2013: MOEF 2007: Pandey et. al. 2009). Although the scope for use of ash in concrete, brick making, soil-stabilization treatment and other applications has been well recognized, only a small quantity of the total ash produced in India is currently utilized in such applications. (Nawaz 2013). Most of the ash generated from the power plants is disposed off in the vicinity of the plant in low lying area as a waste material covering several hectares of valuable land. Ash generated after burning of low quality coal (Lignite) contains many hazardous trace elements like lead (Pb), cadmium (Cd), zinc (Zn), Nickle (Ni), cobalt (Co), copper (Cu), Manganese (Mn), magnesium (Mg) that can leach out and contaminate soil, surface water and groundwater (Deshmukh et. al. 1994; Alper Baba et. al. 2006. It is likely that the trace elements may leach from the ash and get in contact with the host medium (Davison et al. 1974; Kaakinen et al. 1975; Klein et al. 1975; Campbell et al. 1978; Wangen and Williams 1978; Gehrs et

al. 1979; Hansen and Fisher 1980; Hulett et al. 1980; Inyang 1992; Georgakopoulos et al. 1994; Fernandez Turiel et al. 1994; Laumakis et al. 1996; Prasad et al. 1996; McMurphy et al. 1996; Kamon et al. 2000; Baba and Turkman 2001; Güleç et al. 2001; Georgakopoulos et al. 2002; Mandal and Sengupta 2002; Baba 2000; Baba 2003; Baba et al. 2003; Baba and Kaya 2004; Prasad et. al. 2006; Singh et. al. 2010). The major constituents of Fly Ash are primarily oxides of Si, Al, Fe, Ca, and Mg which constitute about 95-99% of total constituent. Minor constituents of Fly Ash are Ti, Na, K, and S comprises 0.5- 3.5% (Ramya et. al. 2012).

The bulk utilization of ash is possible in two areas, namely, ash dyke construction and filling of low-lying areas (Naresh 2010). Coal ash has been successfully used as structural fills in many developed countries. However, this particular bulk utilization of ash is yet to be implemented in India. Since most of the thermal power plants in India are located in areas where natural materials are either scarce or expensive, the availability of fly ash is bound to provide an economic alternative to natural soils. The fly ash and bottom ash generated are mixed in 80:20 ratios and disposed off in ash ponds through huge pipelines. When the hydrogeological conditions are not favorable, the groundwater quality is under threat.

Many coal mines are left abandoned after extraction of coal from the pit without any filling. Filling of these pits is necessary and natural filling material like river sand is not easily available in the vicinity or more expensive. Filling these pits by fly ash is one of the options before the Mining Industries. As disposal of fly ash is a big issue before the Thermal Power Plants, the abandoned mine pit is being used as disposal site for fly ash of late. This generated fly ash is in huge amount and easily available from nearby plants every day.

The present study focuses on the two abandoned mine pits i.e. South balanda Mine pit and Jagannath mine pit, which are used for ash disposal by the nearest Thermal Power Plants (TPP). The power plants generate ash during power production and it is disposed in the abandoned mine pits. The abandoned mine pits are surrounded by the agricultural and urban area. Groundwater and surface water is being directly use by localities for their agricultural and domestic needs. In view of this, it is essential to establish the characteristics of fly ash, mine pit water and the groundwater quality in the watershed surrounding the abandoned mine void.

## 2. Study area

The study area is situated about 15 km from the Angul town in Odisha. The South Balanda Mine pit is spread over an area of 92.82 ha and the Jagannath mine pit is spread over 119 ha area. Subsequently, the ash disposal is being done in abandoned mine pit. In view of the large amount of ash to be disposed in the abandoned pit, it is essential to assess the groundwater quality in the vicinity of the pond and adjoining villages and suggest mitigation measures in the event of any contamination. Both of the mine pits are covered by Survey of India Toposheet (F45 T/1 and F45 T/5 on 1:50,000 scale)

## 3. Objective of the study

The main aim of this research is to assess the groundwater quality and determine the fly ash characteristics. The main objectives of the research are:

- Collection of groundwater samples and analysis for various physico-chemical parameters and trace metals (Al, As, Cd, B, Fe, Se, Cr, V, Hg)
- Physico-chemical and mineralogical characterization of fly ash and bottom ash. The physico-chemical characteristics will include the analysis of particle size, loss on ignition, carbon content, various oxides like $Al_2O_3$, $Fe_2O_3$, $SiO_2$ etc
- Statistical analysis and interpretation of groundwater quality data. This will include the multivariate analysis of groundwater quality data
- Assessment of leaching characteristics of trace metals and fluoride according to pH from pond ash through column experiments
- Assessment of the impact of ash pond on groundwater quality
- Landuse and land cover maps preparation and correlation of the groundwater quality with the land use pattern

## 4. Approach:

The study will be carried out on the basis of the watershed principle. A network of observation wells will be set up in the study area. Pre monsoon and post monsoon sampling of the groundwater samples would be carried out along with the water level measurement. The fly ash and bottom ash samples will be collected from the plant and pond ash will be collected from the ash pond. The analysis of the groundwater

samples will be carried out according to the standard procedures (APHA, 2012). The landuse and landcover maps will be prepared from the satellite imageries. The correlation of groundwater quality data with the land use and land cover maps will be established. The interpretation of the groundwater quality data would be carried out using the sophisticated water quality software AQUACHEM and using the statistical softwares. The multivariate analysis of groundwater would be attempted to define the major parameters governing the groundwater processes and attempt a source apportionment study. Piper diagram, stiff diagram, Wilcox diagram, gibbs plot would be attempted to clearly define the nature of groundwater quality. The fly ash characteristics would be established through TCLP, SPLP tests and other tests as per US-EPA method. The leaching studies of fluoride from ponds ash would be carried out using column experiments. The quality of groundwater will be assessed based on the results obtained from groundwater analysis and fly ash analysis.

## 5. Work Plan:

**1st Year:**

- Course Work
- Literature review
- Preliminary field survey and setting up observation well network
- Demarcation of the study area on the basis of watershed principle and preparation of thematic maps
- Pre monsoon, post monsoon sampling and analysis of groundwater samples

**2n d Year:**

- Collection and analysis of fly ash and bottom ash from ESP's and hopper from the plant
- Collection and analysis of pond ash from the ash pond
- Leaching experiments of fly ash, bottom ash and pond ash
- Preparation of land use and land cover maps and its correlation with groundwater quality data
- Statistical analysis of the groundwater quality data

**3rd Year:**

- Preparation and submission of manuscripts to International SCI Journals
- Final Thesis Preparation

## 6. References:


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